

THE EFFECT OF CASTRATION ON THE ACTIVITY OF
THE ANTERIOR HYPOPHYSIS OF THE MALE
AND FEMALE HAMSTERS

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A THESIS
SUBMITTED TO THE FACULTY OF ATLANTA UNIVERSITY
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF SCIENCE

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ATLANTA, GEORGIA

AUGUST 1951

P. 1-11
P. 35

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INTRODUCTION

The hypophysis of the golden hamster, Cricetus auratus (Waterhouse), undergoes certain cytological changes following castration. By means of sections and microscopical observations these changes have been shown to occur in the basophil, acidophil, and chromophobe cells of the pars anterior of the hypophysis. The most striking changes occur in the basophil cells, which become enlarged and vacuolated, during successive weeks after the operation. The cytological changes that occur in the anterior hypophysis following castration have been described by many investigators, including: Addison ('17); Guyer and Claus ('32); Biggart ('34); Stein ('33), and others. Hanke and Charipper ('48) were apparently the first investigators to study the anatomy, cytology and experimental modifications in the anterior hypophysis of the golden hamster that resulted from castration. Their investigation was confined to a period of nine months following castration in males; and through the period of parturition in females. No sequential study was made on the changes which occur in the anterior hypophysis following castration in the golden hamster. Since it has been shown that castration causes a cytological alteration in the anterior hypophysis, this investigation has value in showing the close relationship which exists between the gonads and the secretory activity of the anterior hypophysis. The purpose of this investigation is an attempt to describe the progressive histo-cytological alterations which take place in the anterior

hypophysis following castration in the golden hamster.

REVIEW OF LITERATURE

It has been known for some time that characteristic changes occur in the hypophysis following castration. Among these are changes in the cytology of the acidophil, basophil and chromophobe cells, which bring about an enlargement of the gland (Hatai '13).

The hypophysis of a normal adult animal is composed of four major parts: the pars anterior; the pars nervosa or pars posterior; the pars intermedia, and the pars tuberalis.

The pars anterior consists of groups of epithelial cells set within a reticular network and separated by capillary channels. Within these groups of cells three types are found: (1) acidophil (eosinophil, oxyphil or alpha cells), so named because they contain numerous small closely-packed granules which stain well with acid dyes; (2) basophil (beta cells), so named because they stain well with basic dyes, and contain coarse granules, and (3) chromophobes (chief cells, reserve cells, or neutrophils), so named because they do not stain well with either acid or basic dyes. Under certain physiological conditions the chromophobe cells are referred to as transitional cells or altered basophil cells because their staining reactions gradually change in such a way that they resemble the basophil cells (Addison '17).

The pars nervosa is composed of a mass of nerve fibers, neuroglia and ependymal cells. The pars intermedia consists of epithelial cells which stain lightly with basic dyes and resemble small basophil cells. The pars tuberalis extends along the

infundibular stalk and forms a cap about it.

The pars anterior shows the most marked changes after castration. Addison ('17), observed that in the albino rat, following castration, there were definite changes in the histological structure of the pars anterior of the hypophysis. After castration the basophil cells became vacuolated two months after the operation, and there was a gradual increase in the number of vacuolated cells during each succeeding month after castration. Many of these large basophil cells became ring shaped in that the cytoplasm and the nucleus of each cell were pushed to the periphery, due to this vacuolation. Addison ('17), described these as "signet ring castration cells". The acidophil cells were not affected too much during the first six months, but some of the cells gradually showed a decrease in the number of granules present, and a decrease in their ability to pick up the stain. After seven months these acidophil cells were reduced in number, and after nine months some of the acidophil cells appeared to be changing into chromophobe cells.

Engle ('29), castrated immature and mature rats and transplanted the anterior hypophysis, on successive days, into the body wall of immature mice and rats. His control group was not castrated, but received glands from normal non-castrated rats. The results of his investigation indicated that the anterior hypophyses of the rats which had been castrated for about eight months contained a greater supply of the gonadal stimulating

hormone than did those which came from normal non-castrated animals. This was shown by the earlier sexual maturity and the increased size of the ovaries in the experimental animals which had received daily transplants from the castrated animals. Engle interpreted his results as indicating that the anterior hypophysis continues to elaborate the gonad stimulating hormone after castration.

To further examine the changes occurring in the anterior hypophysis following castration, Guyer and Claus ('32), transplanted the carcinomas of cancerous rats into the body walls of both male and female normal rats. They found that the same characteristic changes which occurred in the anterior hypophysis after castration took place, including the vacuolation of the basophil cells. The Golgi apparatus became more prominent in both the acidophil and basophil cells. Guyer and Claus ('32), also transplanted the anterior hypophysis of both cancerous and normal castrated animals into immature animals, and found that both glands stimulated ovarian growth and sexual precocity in the young rats and mice. The glands of the cancerous castrated were more potent than those of the normal castrated animals.

Haterius and Nelson ('32), found that extirpation of the gonads brought about certain changes in the anterior hypophysis. These changes included an increase in the weight of the hypophysis together with the appearance of the typical "signet ring castration cells" that were described by Addison ('17). They observed that by transplanting ovarian tissue into the body wall

of castrated rats changes in the hypophysis did not occur. This suggested that the replacement of the sex gland (ovarian implants) prevented structural modifications of the hypophysis.

In 1934, Biggart found that in male and female humans, castration was followed by the characteristic changes in the anterior hypophysis in that the cytological alteration in the three cardinal groups of cells was the same as reported by Addison ('17), Haterius and Nelson ('32), Guyer and Claus ('32).

Wolfe ('34), showed that daily injections of 25 units of pregnancy urine extract (Fallutein-Squibb) into 6-8 days old female rats for periods of 10 and 20 days, produced hypertrophy of the theca interna cells of the ovary, and gave rise to thecal luteinization. There was neither follicular maturation nor formation of true corpora lutea. The pituitaries exhibited an extreme decrease in the level of basophil cells. This indicated that the female hormone (Fallutein-Squibb) was responsible for the level of the basophil cells in the anterior hypophysis.

In 1934, Wolfe made cellular counts of the anterior hypophysis of mature and immature female rats which had been castrated for 15 and 30 days. In the mature rats the level of basophil cells had increased to a mean of 9 per cent in 15 days, and 13.6 per cent in those castrated for 30 days. The basophil cells of the immature rats castrated for 15 days increased to a mean of 15.8 per cent. This suggested to Wolfe that the level of basophil cells was influenced to a greater degree in the immature female castrates than in mature female castrates, even

after a longer period of time .

After finding that the level of basophil cells in infantile female rats which had received injections of pregnancy urine extract decreased in the anterior hypophysis, Wolfe ('34) made a morphological comparison of the anterior hypophysis of normal castrated female rats, and those which had received injections of pregnancy urine extract. He found that the anterior hypophysis of the injected animals and normal control animals were approximately the same.

In addition to the characteristic cytological changes which have been shown to occur in the anterior hypophysis, Stein in 1933, found by means of the paper weight method that the increase in the size of the total hypophysis was due to the increase in the size of the pars anterior. This increase in the size of the anterior portion of the hypophysis was due to the increase in the size of the basophil cells; consequently, the size and weight of the entire gland varied proportionally according to the amount of hypertrophy that took place in the anterior hypophysis of the castrated animals.

Wolfe ('46), recognizing the important role of progesterone in the sexual cycle and the inconsistency of histological findings, attempted to determine the effects of progesterone on the structure of the anterior hypophysis of castrated and non-castrated female rats. Wolfe found that, by administering certain amounts of progesterone, the castration changes were proportional to the amount of progesterone injected. The large

granular acidophil cells became more numerous and the chromophobe cells less abundant. The size of the Golgi apparatus and the distribution of the mitochondria in the acidophil cells, suggested a decrease in the secretory activity of these cells. Wolfe suggested that since vacuoles filled with secretion were found in the basophil cells following castration, the restriction of hypertrophy in the basophil cells of the anterior hypophysis of rats receiving progesterone might have been responsible for the failure of basophilic vacuolation.

In the light of all the evidence presented here by various investigators, Dawson ('46) showed that in properly differentiated preparations of the anterior hypophysis of the cat stained with Heidenhain's azan, two tinctorially distinct types of acidophil cells were demonstrated. These he designated as the acidophil cells (ordinary acidophils), which reacted to orange G, and the carminophil cells (special acidophils), which reacted to azocarmine. The chromophobe cells were colorless to light pink, and the basophil cells were blue, due to the aniline blue component of the stain. According to the observations of Dawson, the carminophil cells rarely appeared in the normal male anterior hypophysis. He mentioned no unusual occurrence of the chromophobe or basophil cells; however, after castration the carminophil cells became significantly aggregated regionally, and produced alveolar patterns. The ordinary acidophil cells were comparable to those of the anterior hypophysis of the normal male. There was no evidence of an increase in the number and size of the

basophil cells as had been recorded by Addison ('17), Wolfe ('34), Stein ('33), Wolfe ('46), and others.

In 1948, Hanke and Charipper found that in the anterior hypophysis of pregnant female hamsters many basophil cells were in varying stages of degranulation. Some of the glands were removed within the last two days prior to parturition which showed numerous sharply outlined deeply stained granular acidophil cells, and fewer large clearly defined basophil cells that were distributed along the blood capillaries. The large elongated basophil cells that are normally found lying alongside the blood capillaries became rounded. No distinct difference in the appearance of the Golgi apparatus was noted when compared with that of a normal animal.

After castration, in the male hamsters, there was an increase in the number of basophil cells in the anterior hypophysis, and the heavily granulated deeply-staining type became more prevalent. There was some increase in the number of vacuolated basophil cells in the gland of the castrated males, which became more marked in the older castrates (133 days old). The vacuolation varied from a condition in which numerous tiny vacuoles were present in the cytoplasm to one in which cells showed one or two large vacuoles that occupied a half or more of the total area of the cell. The nuclei of many of the basophil cells, including both the vacuolated and non-vacuolated cells, consistently took more basophilic stain and became more irregular in outline. There was no marked difference in the

appearance of the Golgi apparatus.

MATERIALS AND METHODS

All animals used in this investigation were the progeny of six pairs of golden hamsters, Cricetus auratus (Waterhouse) purchased from the General Biological Supply House, Chicago, Illinois. All experimental and control animals were fed alike and kept under similar environmental conditions in order to minimize any effects on the hypophysis, except those resulting from castration.

Single cages were provided for each animal, because the smell of blood influenced cannibalistic habits when they were quartered together. Complete data tags were maintained for each animal throughout the duration of this experiment.

The operations were performed on the animals when they were between 30 and 35 days old.

The hypophyses were removed at various periods of time, from one week through four months after castration. Only animals of the same litter were used in each period of this experiment, and in each case controls of that same litter were observed for comparison.

The animals were anesthetized with ether, and placed on a dissecting board with their ventral surfaces up. After the animals were anesthetized, the hair was removed from the area where the incision was to be made. In performing the ovariectomy an incision of one half inch was made in the lateral body wall, parallel to the long axis of the body, about a half inch

away from the vertebral column and one half inch away from the last rib. A pair of cauterizing forceps when inserted in the incision exposed the fat body surrounding the ovary. The ovary and a part of the Fallopian tube were raised to the level of the incision and a ligature was placed below the organ, which was then removed along with a portion of the Fallopian tube. The cut end of the tube was treated with 70 per cent alcohol. The muscle and the skin, were sutured with No. 60 white silk thread.

The above procedure was also followed on the opposite side.

In the males the operations were made through the scrotal sac. An incision of one half inch was made in the mid-ventral region of each sac, parallel to the long axis of the body. The tunica, which surrounds the testis was opened, and the testis was exposed. A ligature was placed around the spermatic cord which contains the vas-deferens, spermatic artery, vein, and nerve. The cord was cut distal to the ligature, and the remaining spermatic cord was immediately replaced in the sac and the skin was sutured. The extirpated organ of each animal was examined under a stereoscopic microscope and preserved in formalin. After the operation the animal was placed in a warm cage in the laboratory for a twenty-four hour observation period and was later returned to the colony in the animal house.

In removing the hypophyses, the animals were killed with

an overdose of chloroform, and the gland was removed. A small portion of the skull was dissected away in the region of the cerebellum, and the exposed portion of the brain was removed. The hypophysis, which lies in the sella turcica of the sphenoid bone, was fixed in situ. Final dissection of the gland followed fixation.

The glands were fixed in Champy's, Helley's, Regaud's, Bensley's and Bouin fluids. They were stained with Methyl green-acid, violet-acid fuchsin, Heidenhain's iron-haematoxylin, Delafield's and eosin, aniline blue-orange G and erythrocin. Osmic acid was used in the Golgi preparations.

The observation and identification of the cell types were based on their staining affinity, and their cellular structure.

EXPERIMENTAL RESULTS

The Normal Hypophysis

The hypophysis of the golden hamster consists of a pars anterior, pars intermedia, pars nervosa and a pars tuberalis. The pars nervosa lies dorsal to the pars anterior within a deep depression. The depression forms a cradle around this mass of nervous tissue. Beneath the pars nervosa a thin portion of the pars anterior is continuous with its broader lateral borders that surround the pars nervosa ventro-laterally. The pars intermedia is closely applied to the pars nervosa, and is separated from the pars anterior by a thin cleft. The pars tuberalis forms a cap of cells about the infundibular stalk. The pars anterior is connected with the pars intermedia by a cord of cells at its anterior and posterior regions. In a cross section the anterior broad surface narrows down toward the mid-line, where, in this region it is inferior to the pars nervosa and intermedia. The pars intermedia is continuous around the ventro-lateral surface of the pars nervosa and is separated by a well demarcated line of epithelial cells, some of which extend into the substance of the pars nervosa. The pars nervosa is continuous with the infundibular stalk and lies somewhat dorso-ventral to the pars anterior (Fig. 1).

THE PARS ANTERIOR

The pars anterior is composed of irregular anastomosing cords of cells, which are set in a network of collagenous and

reticular fibers separated by capillary channels. These cords are composed of groups of cells: the acidophils, basophils, and chromophobes which border the capillary clefts. The cleft that separates the anterior hypophysis from the pars intermedia is lined with small basophil and acidophil cells. According to Hanke and Charipper ('48), there are about 1.9 per cent more acidophil cells in the females than there are in the males, whereas there are slightly more basophil cells in the males. The greatest number of cells in the pars anterior are the chromophobe cells with about an equal distribution of acidophil and basophil cells. There are more of the lightly staining basophil cells in the females, and more of the darkly staining basophil cells in the males.

The cytological details of the hypophysis of both sexes are about the same. The basophil cells are larger than the acidophil cells, and contain both fine and coarse granules (Fig. 2). The nuclei of the basophil cells vary from those with dense chromatin material to those in which the chromatin material is aggregated around the periphery of the nuclei. The Golgi apparatus lies along the side of the nucleus in the basophil cells, and consists of a thread-like network within vacuolated cytoplasm. The mitochondria is located around the nucleus. According to Hanke and Charipper ('48), many of the basophil cells of the anterior hypophysis of older males (8 and 9 months old) appear in various stages of vacuolation.

The cytoplasmic granules are more concentrated on one side of the nucleus in the larger acidophil cells and are scattered

throughout the cytoplasm in the smaller acidophil cells. The faintly staining, centrally placed, nucleus has its chromatin network clumped around the periphery of the nucleus, just as in the basophil cells. The Golgi apparatus is triangular-shaped and closely caps the nucleus.

The chromophobe cells have a very prominent nucleus within a very lightly staining cytoplasm. The cytoplasm is finely granulated, and sometimes completely chromophobic, within a not too well defined cell outline.

THE PARS INTERMEDIA

The pars intermedia is composed of faintly staining basophil cells which contain vesicular ovoid nuclei. These cells are closely packed together, and are without distinct outlines. The cytoplasmic granulation is much finer than that of the basophil cells of the pars anterior. The asymmetrical position of the Golgi apparatus is typical of the basophil cells.

THE PARS NERVOSA

The pars nervosa consists mainly of a mass of neuroglia and nerve fibers. A few epithelial cells which resemble those of the pars intermedia are present between the closely interwoven nerve fibers, blood capillaries and sinuses.

Experimental Hypophyses

One week after castration of the golden hamster a change was evident in the anterior hypophysis which may be progressive throughout the life of the animal. Cytologically the first changes appeared in the basophil and chromophobe cells of the anterior hypophysis. Following castration the basophil cells increased in size and later became vacuolated. The chromophobe cells began not only to stain like the basophil cells, but to resemble them cytologically. The acidophil cells of both male and female hamsters did not show any striking cytological changes and maintained a rather constant appearance.

THE BASOPHIL CELLS

One week after castration of the male animal the large, elongated, finely granulated basophil cells stained much more deeply than in the intact animal, many lost their elongated appearance, becoming ovoid. The cytoplasm of these cells presented a homogeneous appearance with its mitochondria concentrated in the region of the Golgi apparatus. At this stage most of the nuclei were of the vesicular type, usually with three clumps of chromatin material located near the periphery of the nucleus. There were neither signs of degranulation nor of vacuolation in the basophil cells during this period (Fig. 3).

On the other hand, the basophil cells of the female exhibited very slight evidence of any effects of castration after the first week. The lightly staining basophil cells, more

abundant in the hypophysis of the female than in that of the male, showed only an increase in staining capacity. No vacuolation occurred in the basophil cells.

Two weeks after castration of the male, the anterior hypophysis had more of the large, deeply staining basophil cells than did the intact animal. The cytoplasm of these basophil cells was more coarsely granulated, and their nuclei stained much more deeply than those of the one-week castrates. The nuclei of some cells varied from a vesicular ovoid appearance to the dense chromatic type with irregular outlines.

There were a few basophil cells that showed signs of degranulation. Around the periphery of the cell, vacuolated zones began to form (Fig. 4). Tiny vacuoles could be seen in the cytoplasm of the smaller basophil cells. These small vacuoles did not seem to form a larger one but, rather, resulted from partial degranulation which left large granules suspended in the degranulated cell. The elongated types of basophil cells were also observed in the anterior hypophysis at this stage. They too had coarsely granulated cytoplasm which distinguished them from those cells having fine granules.

Two weeks after castration of the female hamster, a large number of vacuolated basophil cells appeared in the anterior hypophysis. In general, the cytological features of these cells were the same as were those found in the male glands of the same age.

Three weeks after castration of the male hamster, the

cytological changes were more pronounced. The basophil cells had increased in size, and vacuolation appeared in more of the cells (Fig. 5). It was noted that the greatest amount of vacuolation took place in the ventral region of the anterior hypophysis. In some cells the vacuolated spaces occupied nearly one-half of the cytoplasm. In the cytoplasm of others, the cells were completely devoid of granules. The number of non-vacuolated cells exceeded the number of vacuolated ones. There was an increase in the staining capacity of the nuclei of these cells; therefore the three clumps of chromatin material observed in the normal animals could not be seen.

In the anterior hypophysis of the female hamster many basophil cells contained small vacuolated spaces. There were two populations of cells recognizable among the basophil cells - large vacuolated cells, and intermediate sizes of non-vacuolated cells. There were large cells without vacuolated spaces. The smaller cells had homogeneous, finely granulated cytoplasm which made it possible to distinguish them from those cells having large, coarse granules (Fig. 6).

One month after castration in the male animal, the differences already observed between the normal and experimental hypophysis were more pronounced. The non-vacuolated cells were more numerous than the vacuolated ones. Not only could some coarsely granulated cells be found along the blood capillaries, but vacuolated and non-vacuolated basophil cells were there as well. The vacuolated cells appeared along the blood capillaries

in no specific pattern. The vacuolated spaces did not appear to have any definite contact with the vascular system. In some cases the vacuolated end of the cell was directed toward the capillary, and yet cells could be found with the vacuolated end turned away from the blood vessel. Some of the cells contained spherical nuclei centrally located, but the nucleus was found to become more eccentrically located as vacuolation increased (Fig. 7).

There were many basophil cells in the anterior hypophysis of the female animals with characteristics similar to those found in the males, but vacuolation had not appeared in as many cells. There were no cells completely devoid of granules after this castration period.

Two months after castration, the anterior hypophysis of the males had many large, coarsely granulated and vacuolated basophil cells. These large vacuolated cells, in the presence of small non-vacuolated cells, gave the hypophysis a different appearance from that of the normal hypophysis with its compact groups of cells. There were cells with small vacuolated spaces about the periphery of the cell and some cells were completely devoid of their granules. There were many cells with granules clustered about their nuclei, and some in which granules were concentrated only on one side. Very little degranulation had taken place in the cells of the most dorsal portion of the gland, but vacuolation was more extensive in the ventral region of the gland toward the periphery (Fig. 8).

Two months after castration of the female hamster, large vacuolated spaces had appeared in a group of cells located in the mid-ventral region of the gland. The process of vacuolation was, to a great extent, the same as that which took place in the basophil cells of the male animals, i. e., beginning with a clear zone around the periphery of the cell and proceeding toward the nucleus. Fewer vacuolated cells appeared in the females than in the males. Vacuolation in the female had been confined to a small group of cells and, even though these cells were completely vacuolated, their outlines were still distinct and that area in which vacuolation had been concentrated had a network-like appearance.

The third month after castration of the male animals, large basophil cells with large vacuoles had appeared throughout the gland, except in the most dorsal portion. In the ventral portion of the hypophysis, vacuolation was so extensive that the entire peripheral region was a network of complete and partially vacuolated cells. Among the cells in which the cytoplasm was completely devoid of granules, only the vacuolated cell outlines remained. Vacuolation in this area (the ventral portion of the gland) ranged from the condition described after one week of castration to that in which whole cells were completely devoid of any granules. In the clear spaces of these cells that had undergone partial degranulation, and hence, vacuolation, large independent granules could be observed (Fig. 9). These vacuoles had irregular outlines of granules which

projected into the lumen of the clear space. Although there were more vacuolated cells, there still could be found cells in the dorsal portion of the gland which had not been affected by the operation.

Vacuolation in the female hamsters was still confined to a limited number of cells, but the process of vacuolation which had occurred was, in general, the same as that which has been described in the males (Fig. 10).

An observation of the male animals castrated for four months showed very little difference in the anterior hypophyses from those of animals which had been castrated for three months. The cells in the ventral portion of the gland were in various stages of vacuolation, while the more dorsal portion of the gland still showed no such change. A general observation of this portion of the gland showed it to be only a coarse network of vacuolated spaces so extensive that the peripheral region seemed devoid of its cells (Fig. 11).

Four months after castration of the female hamster, the anterior hypophysis differed but little from that of the castrates of three months. The basophil cells were no more numerous; however, it was noticed that these vacuolated cells were confined to the mid-region of the gland instead of the peripheral region as in the males (Fig. 12).

THE CHROMOPHOBE CELLS

The indistinct chromophobe cells of the normal hypophysis became more pronounced in both sexes one week after castration.

Their staining capacity had increased to such an extent that it was difficult to distinguish them from the basophil cells.

After successive weeks of castration, these chromophobe cells were observed to react just as did the basophil cells, becoming coarsely granulated and vacuolated. Since one-half of the three cardinal cells in the anterior hypophysis was composed of chromophobic cells, as has been mentioned, vacuolation was the outstanding feature of the gland after four months of castration.

THE ACIDOPHIL CELLS

Throughout the experiment, the acidophil cells, which were observed, showed little or no change in their cytology. In the more dorsal portion of the gland the acidophil cells were found lying close to the blood capillaries and scattered among the basophil and chromophobe cells. In the ventral portion of the anterior hypophysis, where many vacuolated basophil cells occurred in the male animals, the acidophil cells could not be seen; however, in the female animals more acidophil cells could be seen in an unchanged condition.

DISCUSSION

In the hypophysis of the golden hamster there are three distinct types of cells - (1) acidophils, (2) basophils, and (3) the chromophobes. The removal of the testes and ovaries led to an increase in the size and number of the basophil cells. It is believed that these new basophil cells came from chromophobe cells which acquired the characteristics of the basophil cells after castration. Addison ('17) stated that in the rat these chromophobe cells (reserve cells) persist during histogenesis and early growth of the gland, and are continually being changed into the two functional types of cells - the acidophils and the basophils. Haterius and Nelson ('32), Wolfe ('34), Biggart ('34), Guyer and Claus ('33) also found that there was an increase in the size and number of the basophil cells, and that the increase in the number of basophil cells was due largely to the differentiation of the chromophobe cells.

It was observed that in the anterior hypophysis of the golden hamster that the chromophobe cells began to stain like the basophil cells and at the end of the experiment they could not be distinguished from the basophil cells. It is conceivable that up to a certain time in the life history of these chromophobe cells they were all similar and had an equal potentiality for becoming either acidophil or basophil cells.

The "castration cell" Addison ('17), which has been mentioned and observed in the anterior hypophysis of the rat

following castration, was an ovoid basophil cell which resembled a "signet ring". This type of cell was not observed in the anterior hypophysis of the hamster as a result of castration. Most of these vacuolated cells were completely devoid of their cytoplasmic granules and were degenerate in appearance. No such "castration cell" was noticed in the hamster by Hanke and Charipper ('48).

Biggart ('34) found that in human male and female castrates the eosinophil cells (acidophil cells) showed an increase in diameter. Addison ('17) stated that the results of castration affected the acidophil cells of the anterior hypophysis of the rat very little after the first week of castration, but there was a slight diminution in the size of the cells after five months; and after seven months they had lost much of their staining capacity. The results of these experiments show that the acidophil cells maintained a rather constant appearance in the more dorsal portion of the gland, but in the ventral portion of the hypophysis where vacuolation was extensive, the acidophil cells could not be seen. This may have been due to the degenerate appearance of the gland as a whole, or their disappearance may have been due to the loss of much of their staining capacity, just as Addison ('17) found occurring in the rat.

In 1946 Dawson observed that the effects of castration in the female cat were not as extensive as those found in the anterior hypophysis of the male cat. At the end of three months there was little change from the condition found in the normal

animals. In the female hamster vacuolation was not as extensive after castration as in the cells of the anterior hypophysis of the male hamsters, but the changes produced by the operation indicated some of the problems in interpreting the castration reaction. Vacuolation was not extended over the entire periphery of this portion of the gland as it was in the male animals, but it was confined to one or two areas and to a few cells in these areas.

SUMMARY AND CONCLUSIONS

1. The hypophysis of the male and female golden hamster Cricetus auratus (Waterhouse) is composed of four distinct parts - the dorsal pars nervosa, the ventral pars anterior, the pars intermedia, and pars tuberalis.
2. The pars anterior contains three distinct types of cells - the basophils, the acidophils and the chromophobes.
3. Castration produces definite cytological changes in the basophil and chromophobe cells of the pars anterior of the male and female hypophysis.
4. After castration in both sexes the basophil cells increased in size and became coarsely granulated.
5. Vacuolation took place in the coarsely granulated basophil cells three weeks after castration.
6. A greater number of basophil cells increased in size and contained large and small vacuoles one month after castration.
7. After the male animals had been castrated for four months, the ventral peripheral region of the anterior hypophysis contained many vacuolated basophil cells. The largest cells

were completely devoid of their coarse granules, and their centrally placed nuclei were found resting against the cell membrane.

8. After the females had been castrated for four months there were fewer vacuolated basophil cells than were present in the males. Complete vacuolation took place in but a few cells in the mid-region of the anterior hypophysis.
9. Gradually the chromophobe cells began to stain like the basophil cells, and after succeeding months they closely resembled them.
10. The acidophil cells remained rather constant in their cytological appearance throughout the duration of the experiment.

LITERATURE CITED

Articles

- Addison, H. F. "The cell changes in the hypophysis of the albino rat after castration," Jour. Comp. Neuro., Vol. 28, pp. 441-63, 1917.
- Biggart, J. H. "The hypophysis of the human castrate," Bull. Johns Hopkins Hosp., Vol. 54 (3), pp. 157-64, 1934.
- Dawson, A. B. "Some evidence on specific secretory activity of the anterior pituitary gland of the cat," Amer. Jour. Anat., Vol. 78, pp. 347-62, 1946.
- Engle, E. T. "The effect of daily transplants of the anterior hypophysis from gonadectomized rats on immature test animals," Amer. Jour. Physiol., Vol. 88 (2), pp. 101-06.
- Guyer, M. F., and Claus, P. E. "Cell changes in the anterior lobe of the pituitary following cancer transplantations in the rat," Anat. Rec., Vol. 52 (3), pp. 225-39, 1932.
- _____. "Vacuolation of the anterior pituitary gland following castration, implantation of cancer tissue and thyroidectomy," Anat. Rec., Vol. 67, pp. 145-51, 1932.
- Hanke, H. H., and Charipper, H. A. "The anatomy and cytology of the pituitary gland of the golden hamster (*Cricetus auratus*)," Anat. Rec., Vol. 102 (1), pp. 123-39, 1948.
- Hatai, S. "The growth of organs in the rat as affected by gonadectomy," Jour. Exp. Zool., Vol. 18, pp. 1-8, 1913.
- Haterius, H. O., and Nelson, W. O. "Experimental studies of the anterior pituitary," Jour. Exp. Zool., Vol. 61, pp. 175-81, 1932.
- Stein, Sam I. "Experimental studies on the hypophysis cerebri .. II The effect of castration in the male albino rat," Anat. Rec., Vol. 56 (1), pp. 15-29, 1933.
- Wolfe, J. M. "Comparative quantitative effects of castration in mature and immature female rats," Proc. Soc. Exp. Biol. and Med., Vol. 32 (1), pp. 186-89, 1934.

_____. "Anterior pituitaries of infantile female rats receiving injections of pregnancy urine extract," Proc. Soc. Exp. Biol. and Med., Vol. 32 (1), pp. 214-16, 1934.

_____. "Morphological comparison of anterior pituitaries of normal castrated female rats, and those receiving injections of pregnancy urine extract," Proc. Soc. Exp. Biol. and Med., Vol. 32 (1), pp. 184-86, 1934.

_____. "The effects of progesterone on the cells of the anterior hypophysis of the rat," Amer. Jour. Anat., Vol. 79, pp. 199-234, 1946.

PLATE I

Fig. 1

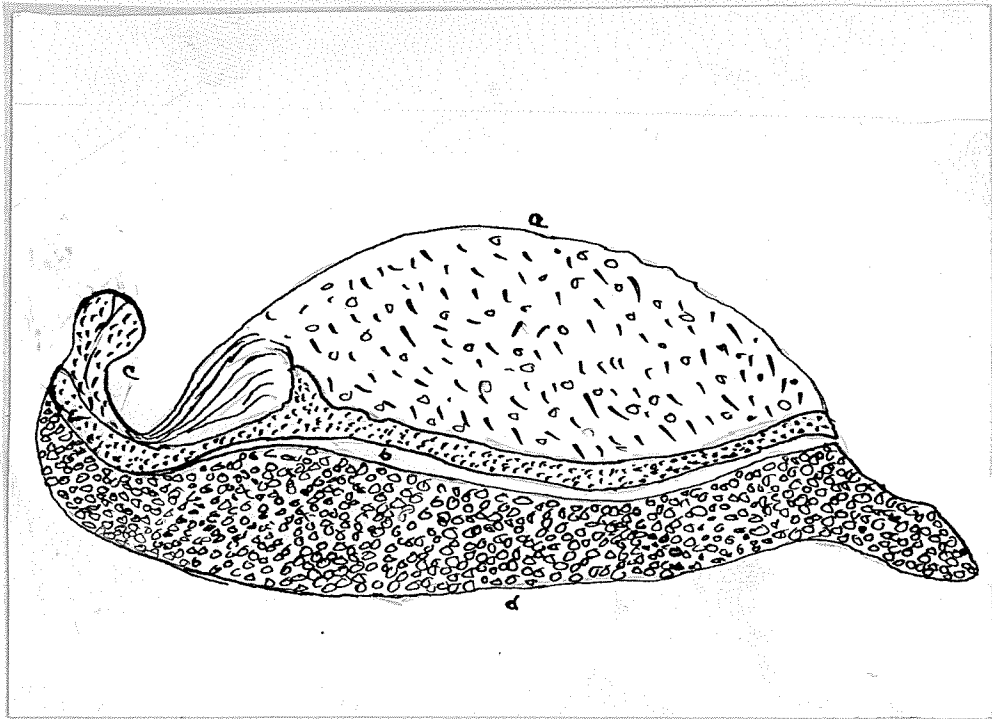
A camera lucida drawing of a longitudinal section through the anterior hypophysis of an adult hamster.

- a. pars nervosa
- b. pars intermedia
- c. pars tuberalis
- d. pars anterior

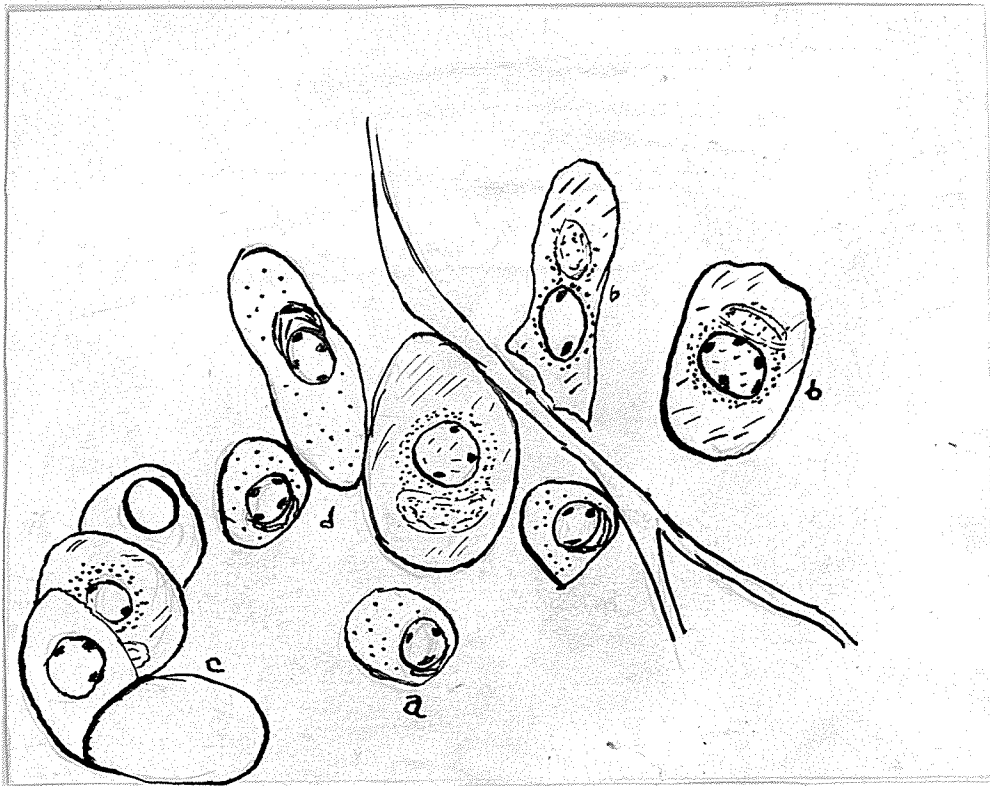
Fig. 2

A camera lucida drawing of a section through a cord of cells showing the cytological structure of the three types of cells. The basophil cells show the Golgi apparatus displaced to one side of the nucleus; in the acidophil cells the Golgi apparatus closely caps the nucleus. Note the distribution of mitochondria throughout the basophil cells; in the acidophil cells the mitochondria are scattered throughout the cell cytoplasm.

- a. acidophil cell
- b. basophil cell
- c. chromophobe cells
- d. Golgi apparatus



1



2

PLATE II

Figures 3-12 are photomicrographs

Fig. 3

A section through the anterior hypophysis of a male animal castrated for one week. Note the enlarged basophil cells, with homogeneous cytoplasm and the vesicular type of nuclei with chromatin clumps near the periphery.

Stained with methyl green and acid fuchsin.

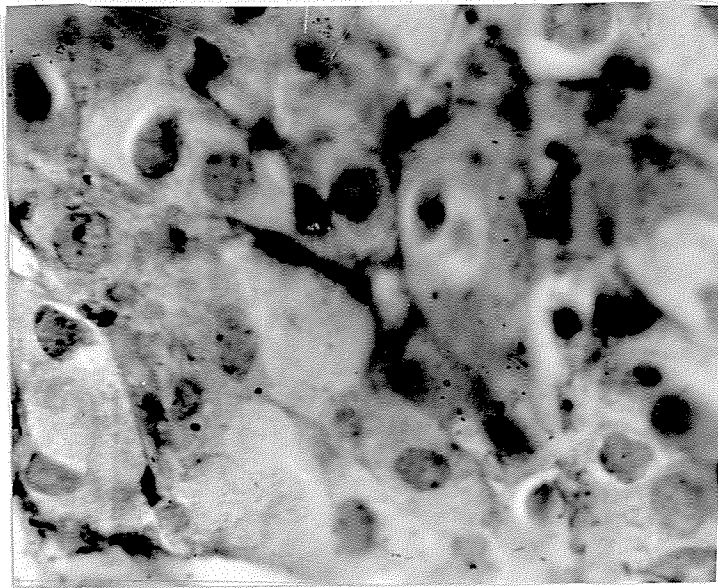
X 986.4

Fig. 4

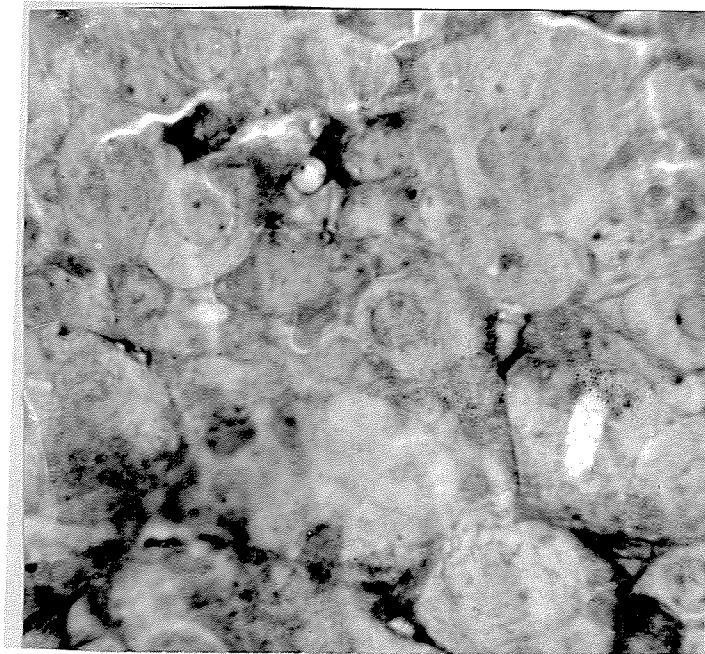
A section through the anterior hypophysis of a male animal castrated for two weeks. Note the elongated basophil cells with coarse granules in their cytoplasm. Two cells, one in the upper and one in the lower portion of the figure, show early vacuolation.

Stained with methyl green - acid fuchsin.

X 986.4



3



4

PLATE III

Fig. 5

A section through the anterior hypophysis of a male animal castrated for three weeks. Note the enlarged basophil cells around a capillary. Small acidophil cells can be seen in the lower right hand portion of the figure.

Methyl green - Acid fuchsin.

X 986.4

Fig. 6

Vacuolation as it occurred in the basophil cells of a female castrated for three weeks. Note large and intermediate sizes of non-vacuolated basophil cells.

Methyl green - Acid fuchsin.

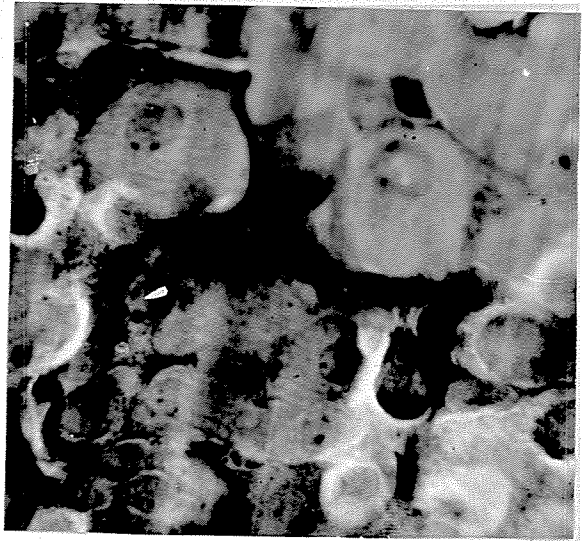
X 986.4

Fig. 7

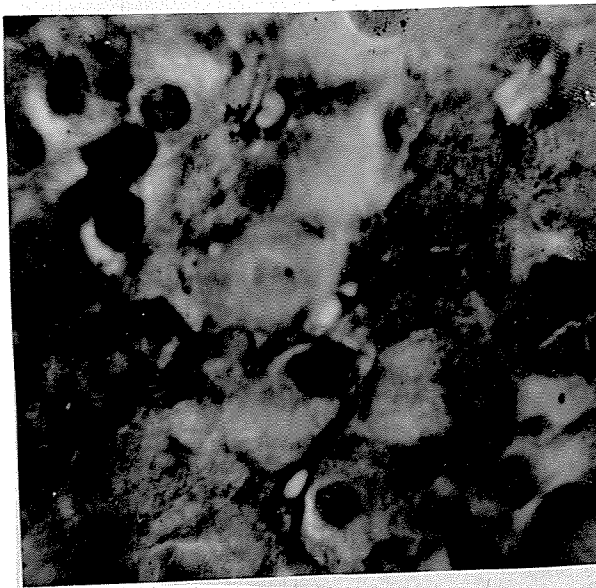
A section through the anterior hypophysis of a male animal castrated for one month. Note the large independent granules around the eccentrically placed nuclei of some of these cells. Most of the cells show degranulated areas around the nucleus.

Methyl green - Acid fuchsin.

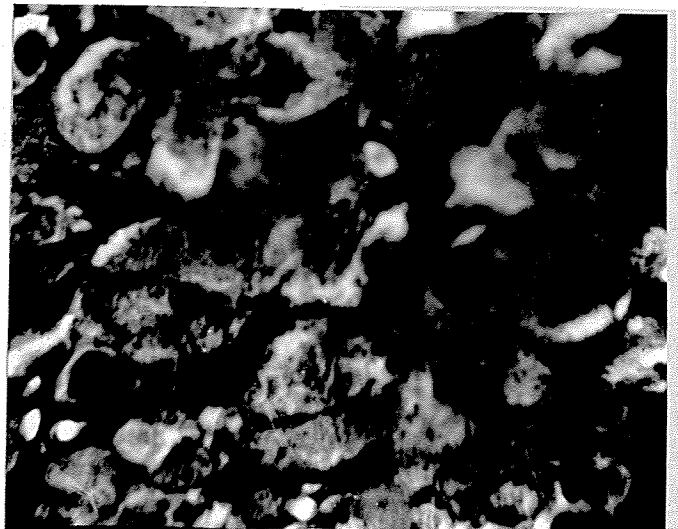
X 986.4



5



6



7

PLATE IV

Fig. 8

A section through the anterior hypophysis of a male animal castrated for two months. Note variety of cells shown: (1) cells completely vacuolated; (2) cells undergoing degranulation; and (3) cells in which no degranulation has occurred. In cells undergoing vacuolation, the nuclei may be seen in their displaced position.

Osmic acid.

X 986.4

Fig. 9

A section through the anterior hypophysis of a male animal castrated for three months, showing many complete and partially degranulated cells. Note the large independent cytoplasmic granules.

X 986.4

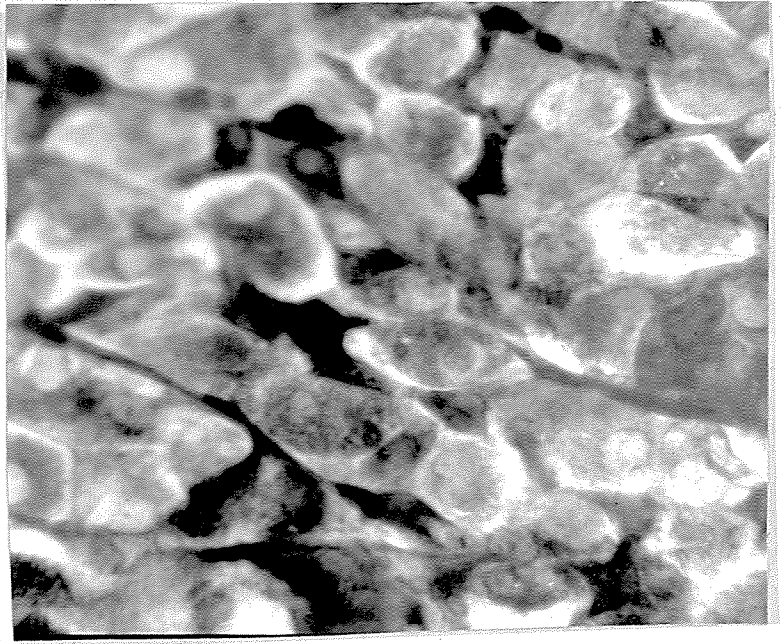
Methyl green - Acid fuchsin.

Fig. 10

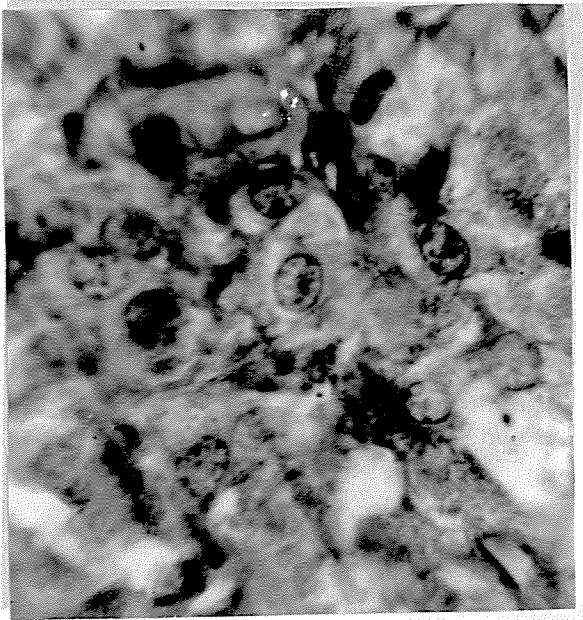
This is a section through the anterior hypophysis of a three month castrated female animal showing fewer complete and partially vacuolated cells. Note the granulated condition of the cytoplasm in the large basophil cells.

Heidenhain's hematoxylin.

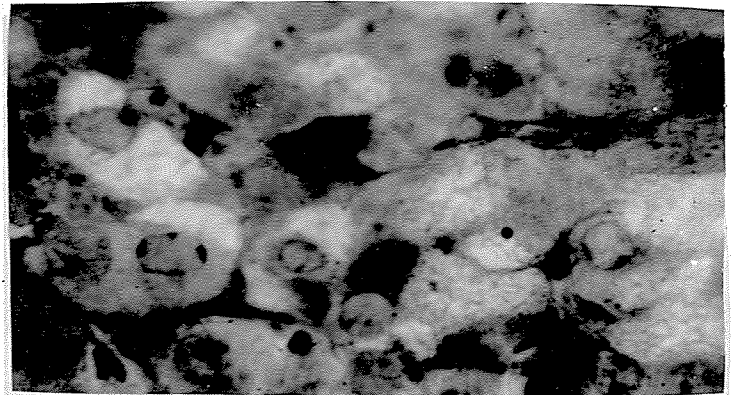
X 986.4



8



9



10

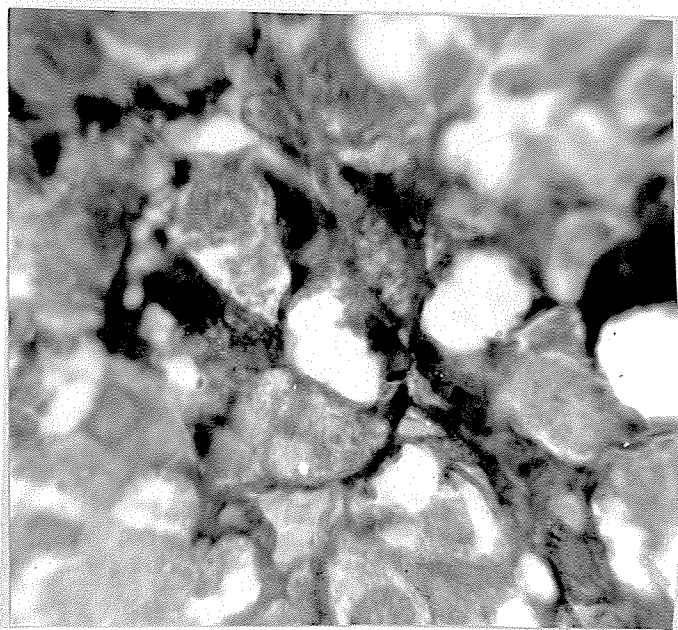
PLATE V

Fig. 11

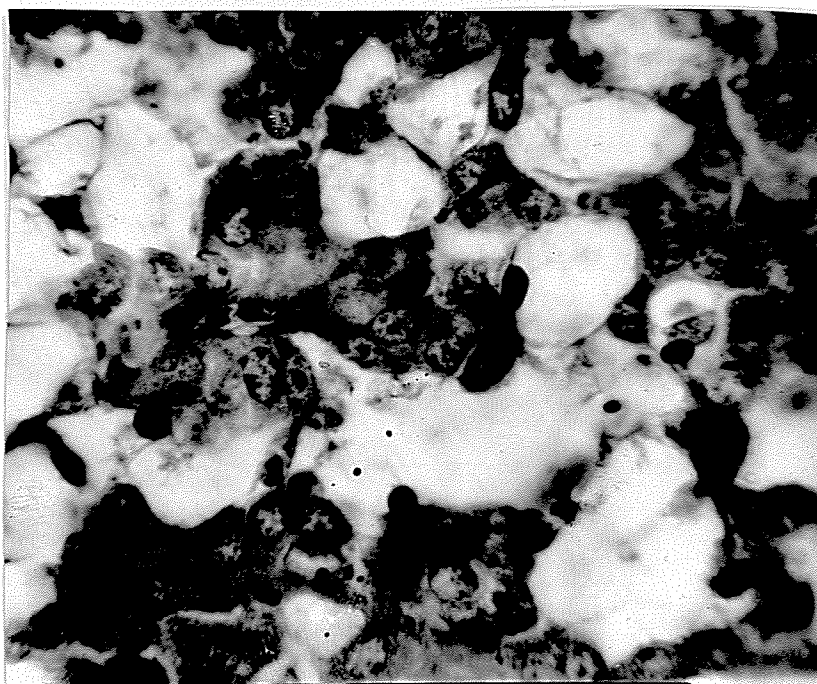
A section through the pars anterior of a four month castrated male animal showing the network appearance as a result of the increased number of complete and partially degranulated basophil cells. Methyl green - Acid fuchsin. X 986.4

Fig. 12

A section through the mid-region of the pars anterior of a female animal castrated for four months. Note the completely vacuolated cells which were confined to this region of the gland. Heidenhain's hematoxylin. X 986.4



11



12